

Text table 2–7.

State sources of R&D expenditures, by functional purpose: FY 1995

	(\$ millions)	Percent
Total	2,431.1	100.0
Science & technology base	1,087.7	44.7
Food, fibre, agriculture	305.4	12.6
Health	243.7	10.0
Economic development	192.1	7.9
Other functions, n.e.c.	158.4	6.5
Environment	110.1	4.5
Education	101.9	4.2
Transportation	80.9	3.3
Natural resources	78.7	3.2
Energy	44.1	1.8
Community development	16.8	0.7
Income security/social services	9.4	0.4
Crime prevention/control	1.9	0.1

SOURCE: Battelle Memorial Institute and State Science and Technology Institute, *Survey of State Research and Development Expenditures FY 1995*. Columbus, OH: Battelle/SSTI, 1998.

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were the primary recipients for funding in both of these categories. “Health” was the single largest functional focus of R&D performed by state agencies; almost 25 percent of the \$244 million state-funded state-performed R&D was health-related. R&D explicitly related to “economic development” accounted for 8 percent (\$192 million) of total state R&D funding in 1995. Reflecting recent trends to use R&D in support of local business and economic growth, however, “economic development” accounted for 38 percent of state R&D funds to industry (\$33 million of the \$87 million provided) and 53 percent of state R&D funds to nonprofit organizations (\$55 million of \$105 million). By comparison, the functionally equivalent category of “economic growth and productivity” accounted for only 5 percent of state funding for R&D to all performers in 1987 and for 2.2 percent of total in 1977 (NSF 1999d).

Historical Trends in Non-Federal Support

R&D financing from non-Federal sources grew by 5.9 percent per year (controlling for inflation) between 1953 and 1980. Between 1980 and 1985, concurrent with gains in Federal R&D spending, it grew at an even faster rate of 7.4 percent per year in real terms. It then slowed to 4.1 percent between 1985 and 1990 and 2.9 percent between 1990 and 1995, but it was back up to 8.4 percent for the 1995–98 period.

Most non-Federal R&D support is provided by industry. Of the 1998 non-Federal support total (\$160.2 billion), 93.4 percent (\$149.7 billion) was company funded, representing a 8.7 percent increase over its 1997 level in real terms. Industry’s share of national R&D funding first surpassed that of the Federal Government in 1980; it has remained higher ever since. From 1980 to 1985, industrial support for R&D, in real dollars, grew at an average annual rate of 7.6 percent. This growth was main-

tained through the mild 1980 recession and the more severe 1982 recession. (See figure 2-1.) Key factors behind increases in industrial R&D have included a growing concern with international competition, especially in high-technology industries; the increasing technological sophistication of products, processes, and services; and general growth in defense-related industries such as electronics, aircraft, and missiles.

Between 1985 and 1994, growth in R&D funding from industry was slower, averaging only 2.8 percent per year in real terms. This slower growth in industrial R&D funding was only slightly greater than the real growth of the economy over the same period (in terms of real GDP), which was 2.4 percent. In contrast, from 1994 to 1998, industrial R&D support grew in real terms by 8.9 percent per year, compared with a 3.4 percent growth rate for the economy overall.

As one might expect, however, growth of industrial R&D varied significantly among different industrial sectors.¹⁸ The largest sectors in recent years have been chemicals and allied products, electrical equipment, machinery, nonmanufacturing, and transportation equipment. (See appendix tables 2-53 and 2-54.) Between 1985 and 1997, the industrial sectors with the highest rates of annual growth in real R&D performance, from non-Federal sources, have been nonmanufacturing (14.7 percent); paper and allied products (4.9 percent); electrical equipment (4.7 percent); and lumber, wood products, and furniture (4.3 percent). Industries experiencing the greatest annual declines (or negative growth) in R&D over the same period were stone, clay, and glass products (–5.3 percent); petroleum refining and extraction (–5.3 percent); primary metals (–2.5 percent); and food, kindred, and tobacco products (–0.9 percent). (See appendix table 2-54.)

R&D funding from other non-Federal sectors—academic and other nonprofit institutions and state and local governments—has been more consistent over time. It grew in real terms at average annual rates of 5.2 percent between 1980 and 1985, 8.2 percent between 1985 and 1990, 2.3 percent between 1990 and 1995, and 3.9 percent between 1995 and 1998. The level of \$10.6 billion in funding in 1998 was 4.8 percent higher in real terms than the 1997 level. Most of these funds have been used for research performed within the academic sector.

Trends in R&D Performance

U.S. R&D/GDP Ratio

Growth in R&D expenditure should be examined in the context of the overall growth of the economy because, as a part of the economy itself, R&D is influenced by many of the same factors. Furthermore, the ratio of R&D expenditures to GDP may be interpreted as a measure of the Nation’s commitment to R&D relative to other endeavors.

A review of U.S. R&D expenditures as a percentage of GDP over time shows an initial low of 1.36 percent in 1953 (when the NSF data series began), rising to its highest peak

¹⁸For studies of patterns of technological change among different industrial sectors, see, for example, Nelson (1995); Pavitt (1984); Utterback (1979).

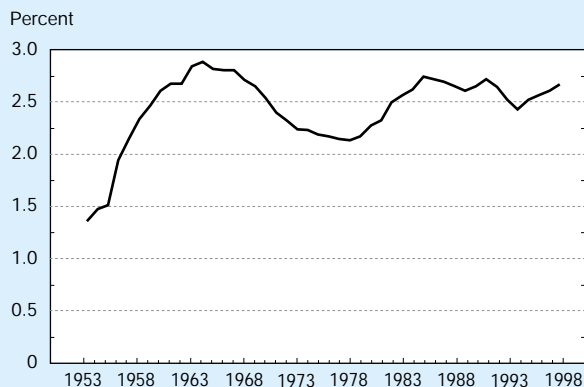
of 2.88 percent in 1964, followed by a gradual decline to 2.13 percent in 1978. (See figure 2-11.) R&D expenditures rose steadily again to a peak of 2.74 percent of GDP in 1985 and did not fall below 2.6 percent until 1993. In 1994, the ratio dropped to 2.43 percent—the lowest it had been since 1981. Starting in 1994, however, R&D/GDP has been on an upward trend as investments in R&D have outpaced growth on the general economy. As a result, the current ratio of 2.67 for 1998 is the highest since 1991.

The initial drop in the R&D/GDP ratio from its peak in 1964 largely reflected Federal cutbacks in defense and space R&D programs, although gains in energy R&D activities between 1975 and 1979 resulted in a relative stabilization of the ratio at around 2.2 percent. (See figure 2-11.) Over the entire 1965–78 period, the annual percentage increase in real R&D was less than the annual percentage increase in real GDP. In years when real R&D spending decreased during that period, real GDP also fell, but at a lower rate.

The rise in R&D/GDP from 1978 to 1985 was as much a result of a slowdown in GDP growth as to increased spending on R&D activities. For example, the 1980 and 1982 recessions resulted in a slight decline in real GDP, but there was no corresponding reduction in R&D spending. During previous recessions, changes in funding for R&D tended to match or exceed the adverse movements of broader economic measures.

R&D/GDP decreased from 2.74 percent in 1985 to 2.61 percent in 1989 but rose to 2.72 percent by 1991. (See figure 2-11.) Again, the ratio tended to fall when GDP experienced relatively fast real growth and rise when it experienced relatively slow real growth. Nevertheless, R&D itself was also affected. The share of R&D that was defense related dropped from 31.1 percent in 1985 to 22.6 percent in 1991. Commensurate with this change was the sharp fall in the share of R&D that was Federally funded—from 46.0 percent in 1985 to 37.8 percent in 1991. (See figure 2-3.) This decline in Federal funding was counterbalanced by increased non-Federal funding.

Figure 2-11.
Historical pattern of R&D as a percentage of
GDP: 1953–98



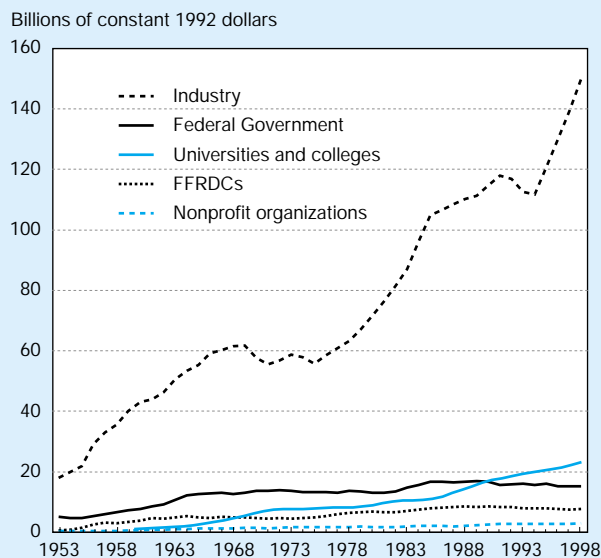
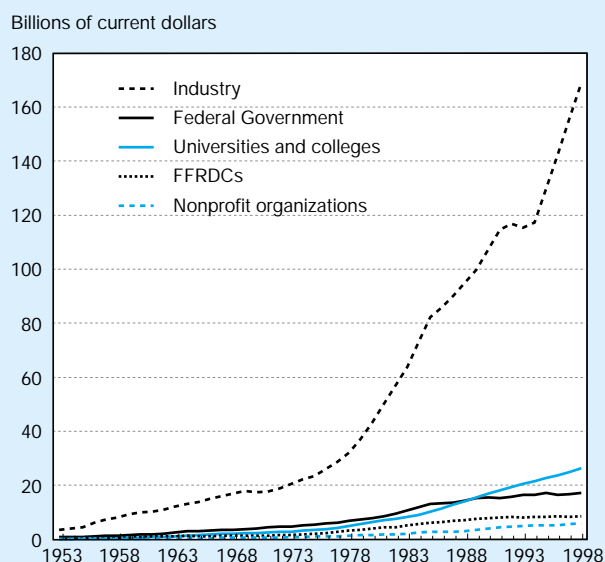
See appendix tables 2-1 and 2-3.

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Rates of Growth Among Sectors

The sectoral shares of U.S. R&D performance, measured in terms of expenditures, have shifted significantly since the early 1980s. (See figure 2-12.) In 1980, industry—including industry-administered FFRDCs—performed 70.3 percent of the Nation's R&D, the academic sector (including academically administered FFRDCs) accounted for 13.9 percent, the Federal Government performed 12.4 percent, and the non-profit sector (including nonprofit-administered FFRDCs) performed 3.4 percent. As industry's defense-related R&D efforts

Figure 2-12.
National R&D performance, by type of
performer: 1953–1998



FFRDC = Federally Funded Research and Development Centers

See appendix tables 2-3 and 2-4.

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accelerated in the early 1980s, its share of the performance total rose to 73.4 percent in 1985.

From 1985 to 1994, R&D performance grew by only 1.1 percent per year in real terms for all sectors combined. This growth was not evenly balanced across sectors, however. R&D performance at universities and colleges (including their FFRDCs) grew by 4.1 percent per year in real terms, compared with 0.7 percent real annual growth for industry, a decline of 0.7 percent per year for Federal intramural performance, and growth of 2.9 percent per year for nonprofit organizations (including their FFRDCs).

The period from 1994 to 1998 witnessed dramatic changes in these growth rates. Total R&D performance, in real terms, averaged 5.8 percent growth per year—substantially higher than in the earlier sluggish period. Yet R&D performance at universities and colleges (including their FFRDCs) grew by only 2.5 percent per year in real terms. Industry R&D performance (including their FFRDCs) grew at a remarkable rate of 7.6 percent in real terms. (See figure 2-7.) Federal intramural performance declined by 0.6 percent per year in real terms. Nonprofit organizations (including their FFRDCs), according to current estimates, saw their R&D increase by only 2.0 percent per year in real terms over the same four-year period.

According to preliminary estimates, in 1998 academia (including FFRDCs) accounted for 14.0 percent of total U.S. R&D performance, Federal intramural activities 7.6 percent, other nonprofit organizations (including FFRDCs) 3.0 percent, and private industry (including FFRDCs) 75.4 percent. (See text table 2-1.)

Federal R&D Performance

The Federal Government, excluding FFRDCs, performed \$17.2 billion of total U.S. R&D in 1998. This figure was slightly higher than the level for 1997 (\$16.8 billion), which reflected only 1.2 percent growth after adjusting for inflation. Federal agencies accounted for 7.6 percent of the 1998 national R&D performance effort—continuing the gradual decline, since 1972, of Federal performance as a percentage of total R&D.

DOD has continued to perform more Federal intramural R&D than any other Federal agency; in fact, in 1998 it performed more than twice as much R&D as the next-largest R&D-performing agency, HHS (whose intramural R&D is performed primarily by NIH). (See text table 2-4.) DOD's intramural R&D performance has grown by less than 1 percent per year in real terms since FY 1980, however, reaching a level of \$7.8 billion in FY 1998. Furthermore, an undetermined amount of DOD's intramural R&D ultimately appears to be contracted out to extramural performers. NASA's intramural R&D has grown by 1.7 percent per year in real terms since 1980, to \$2.5 billion in FY 1998, while HHS intramural performance has grown by 3.7 percent, to \$3.0 billion.¹⁹ To-

gether, these three agencies accounted for 77 percent of all Federal intramural R&D in FY 1998. (See text table 2-4.)

Total R&D performed by industrial, academic, and non-profit FFRDCs combined reached \$8.7 billion in 1998, which is essentially the same as its level of \$8.4 billion in 1997 after adjusting for inflation. R&D at FFRDCs in 1998 represented 3.8 percent of the national R&D effort; most of this R&D (\$5.5 billion in 1998) was performed by university- and college-administered FFRDCs.

Industrial R&D Performance

Recent Growth in Industrial R&D

R&D performance by private industry reached \$171.3 billion in 1998, including \$2.4 billion spent by FFRDCs administered by industrial firms. This total represented a 7.6 percent increase over the 1997 level of \$157.5 billion—which, in turn, reflected a smaller, though still notable, real gain of 6.9 percent over 1996.

In 1998, R&D performed by industry that was not Federally financed rose 8.7 percent in real terms above its 1997 level. Overall, private companies (excluding industry-administered FFRDCs) funded 86.8 percent (\$146.7 billion) of their 1998 R&D performance, with the Federal Government funding nearly all of the rest (\$22.2 billion, or 13.2 percent of the total). Between 1997 and 1998, there was little or no change, in real terms, in Federal funds for these industrial R&D activities. As recently as 1987, the Federal funding share of industry's performance total (excluding FFRDCs) was 31.9 percent; however, the Federal share of industry's performance has been steadily declining since its peak of 56.7 percent in 1959. Much of that decline can be attributed to declines in Federal funding to industry for defense-related R&D activities.

R&D in Manufacturing Versus Nonmanufacturing Industries

The tendency for R&D to be performed more by large firms than small firms is greater in the manufacturing sector than in the nonmanufacturing sector. However, within each of these two sectors there is considerable variation in this regard, depending on the type of industry. Among industrial categories, those in which most of the R&D is conducted by large firms include aircraft and missiles, electrical equipment, professional and scientific instruments, transportation equipment (not including aircraft and missiles), and transportation and utilities (which is in the nonmanufacturing sector). (See text table 2-10.) In these sectors, however, much of the economic activity overall is carried out by large firms; consequently, the observation that most of the R&D in these sectors is conducted by large firms is not surprising.

Probably the most striking change in industrial R&D performance during the past two decades is the nonmanufacturing sector's increased prominence. Until the 1980s, little attention was paid to R&D conducted by nonmanufacturing companies, largely because service sector R&D activity was negligible compared to the R&D operations of companies in manufacturing industries.

¹⁹This increase represents the overall effect on intramural R&D for the agency, which takes into account the Social Security Administration (SSA) becoming a separate agency from HHS during fiscal year 1995. That is, the percentage increase reported would be larger, though negligibly, if HHS in 1995 had been defined as excluding SSA, as it is in 1996.